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AUTHOR Schroeder, David H.
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ABSTRACT

This study examined the construct validity of the Rod and Frame Test (RFT). Subjects were 554 clients (269 males and 285 females) (aged 14 to 65 years) of the Johnson O'Connor Research Foundation (JOCRF), a vocational guidance service. In a battery of diverse ability and style tests (19 tests of the JOCRF battery and 4 tests of cognitive style), the RFT's highest correlations were with spatial visualization. Also, in a principal components analysis, the RFT loaded 0.59 on a spatial ability factor and did not load on any other factors. A multiple regression of the RFT on the cognitive ability tests, however, yielded a multiple correlation of only 0.35. It is concluded that the RFT measures a type of visuospatial ability that is related to other spatial abilities, but is also, to a considerable extent, unique to itself. There is some evidence that the RFT may be more strongly related to spatial visualization among men than among women. A table lists correlations between the RFT and the other ability and style tests. A 10-item list of references is included. (Author/SLD)

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THE CONSTRUCT VALIDITY OF THE ROD AND FRAME TEST

David H. Schroeder

Johnson O'Connor Research Foundation

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ABSTRACT

This study examined the construct validity of the Rod and Frame Test (RFT). In a battery of diverse ability and style tests, the RFT's highest correlations were with spatial visualization (*rs* = .31 and .32, corrected for attenuation). Also, in a principal components analysis, the RFT loaded .59 on a spatial ability factor and did not load on any other factors. A multiple regression of the RFT on the cognitive ability tests, however, yielded a multiple correlation of only .35. It was concluded that the RFT measures a type of visuospatial ability that is related to other spatial abilities but is also, to a considerable extent, unique to itself. There was some evidence that the RFT may be more strongly related to spatial visualization among men than among women.

THE CONSTRUCT VALIDITY OF THE ROD AND FRAME TEST

The Rod and Frame Test (RFT) has traditionally been construed as a measure of field independence, a dimension of cognitive style extending from field independence--the quality of perceiving objects relatively independently of their contexts--to field dependence--the quality of perceiving objects and their contexts in a (relatively) global, undifferentiated manner. The test itself, however, consists of a visuospatial task on which examinees are directed to perform as well as they can (Oltman, 1968). Since the test score reflects the accuracy of examinees' performance, the RFT has the form of an ability test, as distinguished from style tests by Messick (1976) and McKenna (1984): "Abilities are concerned with the effectiveness or level of performance, whereas styles are concerned with the manner or how of performance" (McKenna, 1984, p. 593). In line with this notion, studies have begun to appear that attempt to locate the RFT within the structure of cognitive ability tests (Linn & Kyllonen, 1981; MacLeod, Jackson, & Palmer, 1986). These studies have been limited by their rather small sample sizes (60 subjects each), and, not surprisingly, show somewhat differing patterns of relationships.

The purpose of this presentation is to report a more-definitive study relating the RFT to a reasonably comprehensive set of ability tests in a sample large enough to provide stable correlational values. In light of the established main-effect sex difference on the RFT (Linn & Petersen, 1985), a second purpose is to evaluate whether the pattern of relationships is the same for males and females--i.e., whether the test appears to measure the same attribute in both sexes. Differing patterns have been shown on other visuospatial tests (Linn & Petersen, 1985).

METHOD

Examinees

The examinees for this study were 554 clients of the Johnson O'Connor Research Foundation (JOCRF), a vocational guidance service. The sample contained 269 males and 285 females, ranging in age from 14 to 65. Approximately 20% of the sample were high-school age (14-18), 18% college age (19-22), and the remainder adults, with an overall mean age of 28.8, median of 27, and standard deviation of 10.7. The examinees were mostly college-educated or college-bound and were distributed across the ability range of that population.

Measures

Rod and Frame Test. All examinees took the portable Rod and Frame Test in the eight-trial form that is commonly administered (Oltman, 1968). The scoring method consisted of the standard, summed-deviation-score procedure (McGarvey, Maruyama, & Miller, 1977). Examinees' deviation scores, in degrees from the vertical, were recorded for each trial. These scores were converted to their absolute values and summed across trials to yield total scores. These scores were then reflected in the correlational analyses so that positive correlations represent relationships with superior performance.

For comparison, an alternative scoring method was also used. For each trial, the natural logarithm of the absolute value of the deviation score was computed. These log scores were then summed to yield a total score. As expected, this procedure reduced the skewness in the item scores to near zero. The test reliability, however, was reduced from .93 to .85, and the correlations with other tests were virtually identical to those with the original scoring method. Consequently, the original, simpler scoring method was used in the remainder of the study.

Two additional scores were also computed because previous research had shown them to be relevant to sex differences on the test. For each examinee, their deviations in the direction of the frame ("undercorrections") were summed to create an undercorrection score. Similarly, deviations in the opposite direction from the frame were summed to create an Overcorrection score. Earlier research suggested that females tended to undercorrect more than males.

JOCRF test battery. The examinees also took the standard JOCRF test battery, a set of 19 tests measuring abilities in the areas of spatial ability, reasoning, memory, verbal ability, divergent thinking, musical aptitude, fine dexterity, and perceptual speed. The median reliability for these tests is .86.

Cognitive style tests. In addition to the RFT and the standard JOCRF battery, the examinees also took the following cognitive style tests: the Stroop Color-Word Test, the Matching Familiar Figures Test, the Verbalizer-Visualizer Questionnaire, and a problem-solving style test.

Procedures

Testing commenced in the spring of 1985 and was completed in late fall. The RFT and about half of the other tests were individually administered. The remaining tests were administered in a group format using tape-recorded instructions and slides.

RESULTS

Internal Structure

The mean deviation scores (absolute values) for the eight trials ranged from 1.91 to 2.92 degrees, with *SD*s from 2.89 to 3.68. The corrected item-total correlations varied from .71 to .81. The alpha reliability was excellent, .93.

Sex and Age Differences

The difference between the average deviation scores for males and females was 5.97 degrees, or .28 of the pooled within-sex *SD*, in favor of males. The sex difference was .25 *SD* for undercorrection and .19 *SD* for overcorrection, both in favor of males. Thus, the earlier finding that females undercorrect more than males was confirmed, but in this study females also overcorrected more (in summed degrees) than males.

Regarding age, the examinees were divided into four age groups: 14-18, 19-23, 24-34, and 35-65. These groups differed significantly in RFT scores ($p = .02$), with the following means for standardized, reflected scores: .11, .21, .02, -.13, respectively. This pattern of performance across age is similar to those commonly found for spatial and reasoning abilities and different from the typical pattern for verbal abilities.

Correlational Analyses

The correlations between the RFT and the various ability tests are shown in Table 1, with and without the correction for attenuation. Examining the corrected values, one can see that the strongest relationships for the RFT (*rs* = .31 and .32) are with the two measures of spatial visualization, which are closely related to general spatial ability (Zimowski & Wothke, 1988). The next highest correlations are with a spatial memory test (.25), a general reasoning test (.24), a numerical inductive reasoning test (.23), and a test of knowledge of mathematical terms (.25, uncorrected).

The correlations between the RFT and the cognitive style tests are also shown in Table 1. As can be seen, all the relationships are weak or nonsignificant.

When the RFT was regressed on the 13 other cognitive ability tests[1] in the standard JOCRF battery (using uncorrected correlations), the multiple correlation was only .35.

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[1]The specific tests included here are Wiggly Block, Paper Folding, Analytical Reasoning, Number Series, English Vocabulary, Reading Comprehension, Ideaphoria, Foresight, Memory for Design, Silograms (Word Memory), Number Memory, Observation, and Number Checking. These same tests were included with the RFT in the principal components analyses.

Table 1

Correlations Between the RFT and Other Ability and Style Tests

Test	Relia.	Corr w/ RFT[a]	Attribute measured
Rod and Frame Test	.93	--	--
Spatial visualization			
Paper Folding	.82	.28/.32	Spatial visualization[b]
Wiggly Block	.73	.25/.31	Spatial visualization[b]
Reasoning			
Analytical Reasoning	.65	.19/.24	General reasoning[b]
Number Series	.87	.21/.23	Numerical reasoning[b]
Memory			
Memory for Design	.80	.21/.25	Memory for visual designs[b]
Silograms (Word Memory)	.92	NS	Verbal associative memory[b]
Number Memory	.82	NS	Memory for numbers[b]
Observation	.62	NS	Memory for fine visual details[b]
Verbal ability			
English Vocabulary	.96	NS	Vocabulary knowledge[b]
Reading Comprehension	.81	NS	Reading comprehension[b]
Divergent thinking			
Ideaphoria	.97	NS	Ideational fluency[b]
Foresight	.97	NS	Visual imagination[b]
Musical aptitude			
Tonal Memory	.92	.14/.15	Memory for sequences of tones
Pitch Discrimination	.80	.15/.17	Ability to discriminate pitches
Rhythm Memory	.73	NS	Memory for rhythms

Note. Scores on the Rod and Frame Test were reflected so that positive correlations indicate positive relationships with the other tests.

[a]The values to the left of the slash represent the uncorrected correlations, the values to the right the correlations corrected for attenuation.

[b]These are the cognitive ability tests used in the factor analysis.

Table continues

Table 1 (cont'd)

Correlations Between the RFT and Other Ability and Style Tests

Test	Relia.	Corr w/ RFT[a]	Attribute measured
Fine dexterity			
Finger Dexterity	.86	NS	Finger dexterity
Tweezer Dexterity	.93	.11/.12	Small-instrument dexterity
Cognitive style			
Stroop Color-Word	.70	.11/.14	Distractibility
Matching Fam. Figures	.89	.12/.13	Impulsivity (low scores) vs. reflectivity (high scores)
Verb.-Vis. Ques.	.56	NS	Verbal (low) vs. visual (high) style
Problem-Solving Style	NA	NS	Global (lo) vs. analytic (hi) style
Other			
Number Checking	.96	NS	Perceptual speed[b]
Mathematics Vocabulary	NA	.25/--	Knowledge of math terms

Note. Scores on the Rod and Frame Test were reflected so that positive correlations indicate positive relationships with the other tests.

[a]The values to the left of the slash represent the uncorrected correlations, the values to the right the correlations corrected for attenuation.

[b]These are the cognitive ability tests used in the factor analysis.

Principal Components Analysis

The RFT and the 13 other cognitive ability tests were subjected to a principal components analysis. The eigenvalues for the first six factors were as follows: 3.93, 2.07, 1.49, .96, .86, and .78. Factor solutions were rotated to the varimax criterion for three-, four-, five-, and six-factor solutions, and the rotated four-factor solution yielded the most interpretable results. The factors can be interpreted as representing spatial ability, memory, verbal ability, and divergent thinking, respectively. The RFT loaded .59 on the spatial ability factor and only .07, .06, and .00 on the other factors. This amplifies the finding from the correlational analyses that the RFT is related to spatial visualization and little else (with the possible exception of reasoning). Also, the communality of the RFT in the four-factor solution was only .35.

Examining the simple correlations, multiple regression, and principal components analysis together, one sees a pattern in which the RFT is clearly related to the other spatial tests, but possesses a sizable proportion of variance unique to itself. If one subtracts the square of the multiple correlation from the test reliability, one obtains an estimate of 81% of the variance in the RFT as reliable and unique relative to measures of other cognitive abilities.

Separate-Sex Analyses

The patterns of correlations for males and females separately tended to be similar to each other and to the overall pattern. The corrected correlations for the RFT with Wiggly Block, a spatial visualization test, were .44 for males and .19 for females, a difference that is significant with $p = .011$, for the statistical test presented in Hays's textbook (1973, pp. 663-664). The corresponding correlations for the other visualization test, Paper Folding, were .38 and .27, a difference that was in the same direction as for Wiggly Block but was not significant (p = about .25). These findings suggest that in their RFT performance, males may rely more on their visualization ability, whereas females may rely more on other abilities. Linn and Petersen (1985) and Zimowski and Wothke (1988) have advanced similar hypotheses for other visuospatial tests. In this context, it is interesting that the RFT correlated more highly with Number Series, a numerical inductive reasoning test, among women (.27) than men (.16), although again the difference is not significant.

The principal-component analyses were performed separately for males and females. The rotated four-factor solutions were very similar to each other and to the full-sample solution. This suggests that the correlational differences noted earlier may be less substantial than they appear to be.

CONCLUSIONS

These results support to some extent the interpretation of the RFT advanced by Linn and Kyllonen (1981) and Linn and Petersen (1985)--namely, that the RFT measures a type of visuospatial ability that is somewhat related to other spatial abilities. This study also indicates, however, that to a considerable extent, the construct measured by the RFT is distinct from standard cognitive ability measures. In addition, this construct is distinct from cognitive styles. Further research will be needed to isolate this dimension. Following on Linn and Kyllonen, the RFT may be related to the Piaget's Water Level test (Wittig & Allen, 1984) and possibly other tests that involve judgments of the orientation of lines in space.

There was also some limited evidence in this study that the RFT may be more strongly related to spatial visualization among men than among women, although more data will be needed to resolve this issue.

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